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Optimal Import Quotas in Oligopolistic Markets

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Abstract

Typically the literature on trade policy in the presence of imperfect competition has derived optimal tariff and subsidy policies that maximize economic welfare. However, given that non-tariff policies are more common forms of protection, this paper focusses on the derivation of optimal import quotas. Specifically, the impact of incomplete capture of quota rents by the home government is evaluated. The results indicate that as foreign firms are able to capture more rents, the optimal import quota should be made more restrictive. In the limit, where the home government captures no rents, a virtually prohibitive quota is optimal.

1. Introduction

Recent developments in the international economics literature have focussed on the impact of imperfect competition in international markets. In particular, a theoretical rationale has been given for the use of protectionism or what have been termed strategic trade policies. The standard justification for such policies is that of "rent-shifting" (see, for example, Brander and Spencer, 1985, and Dixit, 1984). The basic idea is that a government can alter the nature of competition between firms for monopoly rents in imperfectly competitive markets.

Typically, this literature has considered the role of tariffs and export subsidies as a means of increasing national welfare. However, observation would suggest that governments tend to use non-tariff restrictions such as import quotas. Such forms of protection have received somewhat less attention in the strategic trade policy literature, though the effects of quotas in a price-setting framework have been considered by Harris (1985) and Krishna (1989) and in a quantity-setting framework by Hwang and Mai (1988) and Fung (1989).

In this paper, an expression for an optimal quota is derived and evaluated, using a theoretical framework originally suggested by Dixit (1988). In particular, it is shown that when quota rents are not fully captured by the home government, the optimal level of imports should be more restrictive. The relationship between the quota and level of rent capture is such that in the limit where the government captures no rents, a virtually prohibitive quota is shown to be optimal. Hence, by implication, observed voluntary export restraints are unlikely to be welfare maximizing.

The paper is outlined as follows. In Section 2, a general conjectural variations model of oligopoly is outlined, drawing on a model originally suggested by Dixit, and in Section 3, this model is used to derive an expression for an optimal import quota that is equivalent to an optimal

import tariff. Section 4 considers the extent to which such an optimal quota would vary with the extent of rent capture by the home government.

2. Theoretical Model

The model of oligopoly used in this paper follows that of Dixit. A situation is considered where domestic firms compete with imports, the essential features of the model being the use of a general conjectural variations approach, where the conjectural variations parameters are left free, allowing different forms of oligopolistic behavior; firms' costs are assumed to be constant; home produced goods (subscript 1) and imported goods (subscript 2) are treated as imperfect substitutes.

Focussing on the home market, consumer surplus is given by:

$$\Gamma = f(Q_1,Q_2) - p_1Q_1 - p_2Q_2 \tag{1}$$

where the utility function $f(Q_1,Q_2)$ is defined as:

$$f(Q_1,Q_2) = a_1Q_1 + a_2Q_2 - \frac{1}{2}(b_1Q_1^2 + b_2Q_2^2 + 2kQ_1Q_2) \tag{2}$$

From (1) and (2) the inverse demand functions for the home produced and imported goods can be derived:

$$p_1 = a_1 - b_1Q_1 - kQ_2 \tag{3}$$

$$p_2 = a_2 - kQ_1 - b_2Q_2 \tag{4}$$

where all parameters are positive, $b_1b_2-k^2\geq 0$ since the products may be imperfect substitutes, p_1 and p_2 are prices and Q_1 and Q_2 are quantities.

On the supply side, there are n_i firms in the home and foreign economies. Profits for a representative firm in each country are given by:

(5) $$\pi_1 = (p_1 - c_1)q_1 - f_1$$

(6) $$\pi_2 = (p_2 - c_2 - r)q_2 - f_2$$

where prices and quantities are as defined above, c_i and f_i are marginal and fixed costs respectively and r is a rent per unit of import which is assumed to be captured by the home government through selling quota licenses.

As noted earlier, the model is one where firms' reactions to one another are treated as a Nash equilibrium with conjectural variations. The conjectural variations parameters are derived from the first-order conditions of the respective profits functions:

(7) $$p_1 - c_1 + q_1 dp_1/dq_1 = 0$$

(8) $$p_2 - c_2 - r + q_2 dp_2/dq_2 = 0$$

where dp_i/dq_i is the conjectural variations parameter, i.e. the firm's expectation of how market prices will vary with changes in its output. Therefore, if a representative firm plays Cournot, it believes rival firms will not change output in response to a change in q_i, hence $dp_i/dq_i=-b_i$, the slope of the inverse demand function. If the market were perfectly competitive, a change in one firm's output would have no effect on market price, i.e.

$dp_i/dq_i = 0$.

Aggregating over the n_i firms generates:

(9) $$p_1 - c_1 - Q_1 V_1 = 0$$

(10) $$p_2 - c_2 - r - Q_2 V_2 = 0$$

where V_i is the aggregate conjectural variations parameter. Thus, for Cournot behavior,

$V_i=-b_i/n_i$ and as n_i increases, the more competitive the Cournot outcome becomes. In the limit $V_i=0$, i.e. perfect competition.

Finally, equilibrium prices and quantities in the model are obtained by combining (3) and (4) with (9) and (10), the explicit solutions for prices and quantities being:

(11)
$$\begin{bmatrix} Q_1 \\ Q_2 \end{bmatrix} = \frac{1}{\Delta'} \begin{bmatrix} b_2+V_2 & -k \\ -k & b_1+V_1 \end{bmatrix} \begin{bmatrix} a_1-c_1 \\ a_2-c_2-r \end{bmatrix}$$

(12)
$$\begin{bmatrix} p_1 \\ p_2 \end{bmatrix} = \begin{bmatrix} a_1 \\ a_2 \end{bmatrix} - \frac{1}{\Delta'} \begin{bmatrix} \Delta+b_1V_2 & kV_1 \\ kV_2 & \Delta+b_2V_1 \end{bmatrix} \begin{bmatrix} a_1-c_1 \\ a_2-c_2-r \end{bmatrix}$$

where $\Delta = (b_1b_2 - k^2)$, $\Delta' = (b_1 + V_1)(b_2 + V_2) - k^2 = (\beta_1\beta_2 - k^2)$, $\beta_i = (b_i + V_i)$

3. Optimal Import Quotas

The home government's objective is to choose a policy to maximize national welfare[1], which is the sum of consumer surplus Γ, domestic firms' profits and government revenue as given by:

(13)
$$W = \Gamma + Q_1(p_1 - c_1) + \alpha r Q_2 \quad , \quad 0 \le \alpha \le 1$$

where r is the per unit quota rent, and α is a parameter indicating the level of rent capture by the government, i.e. for a system of import licences that captures all the quota rents, $\alpha=1$, while for a voluntary export restraint, $\alpha=0$.

Substituting in for Γ from (1), (13) can be re-written as:

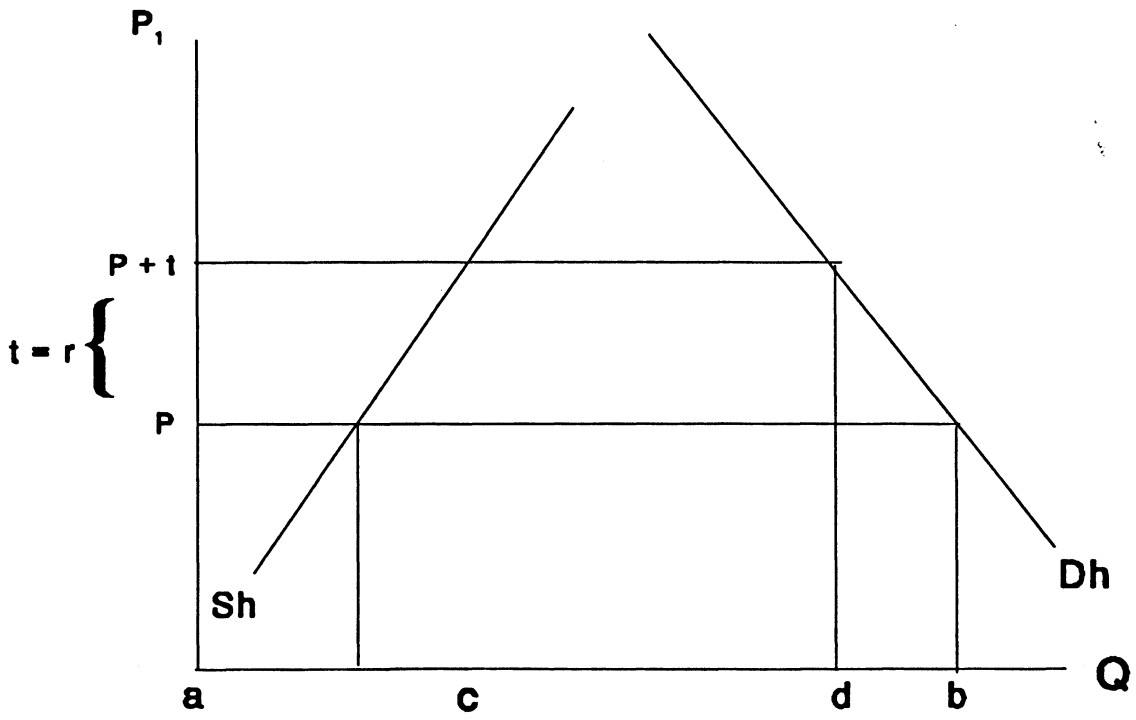
(14)
$$W = f(Q_1,Q_2) - c_1Q_1 - p_2Q_2 + \alpha r Q_2$$

For present purposes, the optimal quota is defined along the lines traditionally followed in the international trade literature regarding the equivalence between tariffs and quotas from Shibata (1968) onwards, i.e. the (optimal) quota is the level of imports that would be generated

[1] As Dixit has shown, in a full optimum policies are targeted at both the domestic and foreign market distortions. Here the focus is on the trade distortion alone, what Dixit has called the constrained optimum, where the trade instrument partially counters the domestic distortion.

by the (optimal) tariff. Hence, in **Figure 1**, a tariff t would lead to the import level cd as compared to free trade imports of ab, hence the quota-equivalent of the tariff would be cd. In addition, if the per unit tariff t is treated as optimal, it implies an optimal per unit quota rent of r, assuming complete capture of the rents by the domestic government through a system of import licences, i.e. α=1.

Figure 1



Therefore, in terms of the model outlined above, the optimal per unit quota rent is derived by maximizing expression (13) with respect to r. Using (2), (10), (11) and (12), the first-order condition for maximization is:

(15) $$r = \frac{k(a_1 - c_1)(V_1\beta_2 - V_2\beta_1) + (a_2 - c_2)(V_2\beta_1^2 - k^2V_1)}{\beta_1^2(\alpha\beta_2 + V_2) - k^2(\alpha\beta_1 + V_1)}$$

This expression is similar to that derived by Dixit for an optimal per unit tariff, except that the parameter α appears in the denominator, which accounts for the extent of rent capture by the home government.

The optimal quota-equivalent of the tariff/quota rent is derived by substituting expression (15) into (11):

$$\textbf{(16)} \qquad \overline{Q_2} = \frac{1}{\Delta'}\left[-k(a_1 - c_1) + \beta_1(a_2 - c_2 - r)\right] \ , \ \textit{where } \delta\overline{Q_2}/\delta r < 0$$

which after re-arranging, gives the following expression for the quota $\overline{Q_2}$:

$$\textbf{(17)} \qquad \overline{Q_2} = \frac{\beta_1}{\Delta'}(a_2 - c_2)\left[1 - \frac{V_2\beta_1^2 - k^2V_1}{\varepsilon}\right] - \frac{k}{\Delta'}(a_1 - c_1)\left[1 + \frac{\beta_1(V_1\beta_2 - V_2\beta_1)}{\varepsilon}\right]$$

$$\textit{where} \quad \varepsilon = \beta_1^2(\alpha\beta_2 + V_2) - k^2(\alpha\beta_1 + V_1) \ , \ \delta\overline{Q_2}/\delta c_1 > 0 \ , \ \delta\overline{Q_2}/\delta c_2 < 0 \ \textit{and} \ \delta\overline{Q_2}/\delta V_i < 0$$

So from (16) and (17), the following proposition can be established.

Proposition 1. If α=1, and given values for a_i, b_i and k, the optimal quota-equivalent of the tariff/quota rent can be derived from the government's welfare maximizing problem, and can be shown to vary negatively in the level of the optimal quota rent, positively and negatively in the costs of home and foreign firms respectively, and inversely in their conjectural variations.

It should be noted here that tariffs and import quotas are deemed to be equivalent if the domestic prices of the good are identical following the imposition of the policy. Much of the literature on the non-equivalence between these trade policies has considered the polar cases of monopoly and perfect competition (see Helpman and Krugman, 1989). However, in the present context, the effects of quota restrictions will have an additional effect of changing the conjectures of firms competing in the market. Essentially, the domestic firm will know the response of its competitor as the foreign firm's reaction function will be kinked where the quota is binding. On

this issue, Hwang and Mai have shown that if the home firm's conjectures were more (less) competitive than Cournot, the effect of the quota is to raise (lower) domestic prices, relative to those that would have prevailed in the presence of tariffs.

Since, following the imposition of the quota, the home firms act in a Cournot-manner (i.e. they know that there will be no response from their foreign competitors) and that the foreign firms' conjecture is undefined where the quota is binding (i.e. V_2=0), the effect of the import quota on Q_1 is given as:

$$(18) \qquad Q_1 = \frac{b_2a_1 - ka_2 + kc_2 + kr - c_1b_2}{(b_1 + V_1^c)b_2 - k^2} \quad , \quad where \ \delta Q_1/\delta r > 0$$

which is derived from (11), where V_1^c is the Cournot-equivalent conjecture for the domestic firms.

From (18), the following proposition is derived.

Proposition 2. The equilibrium level of the domestic firms' output will vary positively in the optimal per unit rent and hence negatively in the output restriction imposed on the foreign firms.

4. Incomplete Capture of Quota Rents

In deriving *Propositions 1* and *2*, it was assumed that the government completely captures the rents from imposing an optimal quota, i.e. α=1. However, there is often incomplete capture of quota rents, either because of low import licence fees or because of the use of voluntary export restraints, whereby no quota rents are captured by the domestic government. Hence, the interest is in evaluating the optimal quota when α is less than 1.

It is easiest to initially consider this problem in terms of the optimal quota rent expression (16). This is simplified in the following manner:

$$\textit{Let } \lambda = (a_1 - c_1)k(\beta_2 V_1 - \beta_1 V_2) + (a_2 - c_2)(\beta_1^2 V_2 - k^2 V_1)$$

$$\textit{and } \gamma_1 = (\beta_1^2 \beta_2 - \beta_1 k^2) \; ; \; \gamma_2 = (\beta_1^2 V_2 - k^2 V_1)$$

(19) $$r = \frac{\lambda}{\alpha \gamma_1 + \gamma_2}$$

In order to define the relationship between r and α, the first and second-order derivatives of (19) with respect to α are evaluated:

(20) $$\frac{\delta r}{\delta \alpha} = -\lambda(\alpha \gamma_1 + \gamma_2)^{-2}\gamma_1 < 0, \quad \textit{if } \alpha, \lambda, \gamma_1 \textit{ and } \gamma_2 > 0$$

(21) $$\frac{\delta^2 r}{\delta \alpha^2} = 2\lambda(\alpha \gamma_1 + \gamma_2)^{-3}\gamma_1^2 > 0 \; , \quad \textit{if } \alpha, \lambda, \gamma_1 \textit{ and } \gamma_2 > 0$$

α is positive by definition, and if the optimal quota rent r is positive, then λ, γ_1 and γ_2 are also positive, hence the first and second order derivatives will be negative and positive respectively. In other words, the relationship between the optimal quota rent and the level of rent capture α is quasi-hyperbolic.

Substituting (19) into (11), the relationship between the optimal quota and level of rent capture can be derived and evaluated:

(22) $$\overline{Q_2} = \frac{1}{\Delta'}\left[-k(a_1 - c_1) + \beta_1(a_2 - c_2 - \{\lambda / \alpha \gamma_1 + \gamma_2\})\right]$$

Taking the first and second-order derivatives of (22) with respect to α:

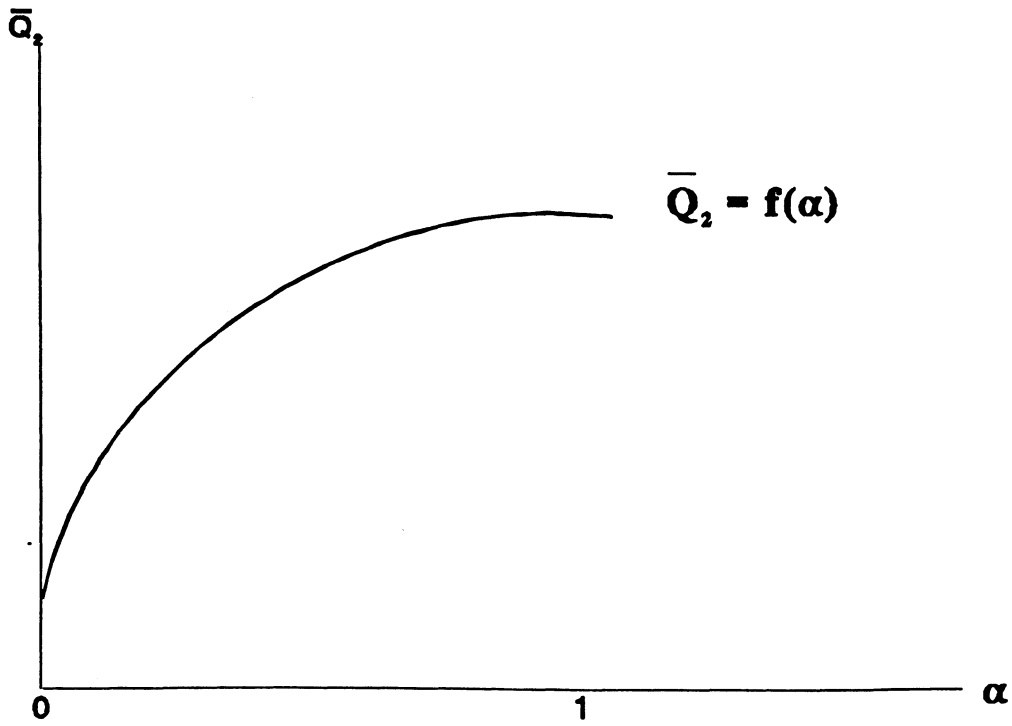
(23) $$\frac{\delta \overline{Q_2}}{\delta \alpha} = \Delta'^{-1}\beta_1\lambda(\alpha\gamma_1 + \gamma_2)^{-2}\gamma_1 > 0 \text{ if } \alpha,\lambda,\gamma_1 \text{ and } \gamma_2 > 0$$

(24) $$\frac{\delta^2 \overline{Q_2}}{\delta \alpha^2} = -2\Delta'^{-1}\beta_1\lambda(\alpha\gamma_1 + \gamma_2)^{-3}\gamma_1^2 < 0 \text{ if } \alpha,\lambda,\gamma_1 \text{ and } \gamma_2 > 0$$

Again, α is positive by definition and λ, γ_1 and γ_2 are positive if the optimal quota rent is positive. Therefore, the following proposition can be stated.

Proposition 3. The level of the optimal quota $\overline{Q_2}$ is a positive but diminishing function of the level of quota rent capture α. In the limit as α approaches zero, i.e. a voluntary export restraint is implemented by the home government, a virtually prohibitive quota will be optimal (see **Figure 2**).

Figure 2



To complete the analysis, the effect of incomplete capture of quota rents on the equilibrium level of home firms' output can be derived by substituting (19) into (18) and differentiating with respect to α:

$$(25) \qquad Q_1 = \frac{b_2 a_1 - k a_2 + k c_2 + k\{\lambda/\alpha\gamma_1 + \gamma_2\} - c_1 b_2}{\theta} \quad , \quad \textit{where } \theta = b_1 + V_1^c) b_2 - k^2$$

$$(26) \qquad \frac{\delta Q_1}{\delta \alpha} = -\theta^{-1} k \lambda (\alpha\gamma_1 + \gamma_2)^{-2} \gamma_1 < 0 \textit{ if } \alpha, \lambda, \gamma_1 \textit{ and } \gamma_2 > 0$$

Given the correct signs on the parameters, the following proposition can be stated.

Proposition 4. The equilibrium level of the domestic firms' output will vary negatively in the level of quota rent capture α.

5. Summary

This paper has considered the effects of import quotas in oligopolistic markets. Given a general conjectural variations model of oligopoly, an expression for the quota-equivalent of an optimal tariff can be derived. Critically, it has been shown that the optimal level of the quota will be more restrictive the more incomplete is the level of rent capture by the domestic government. By implication, when a voluntary export restraint is used, a very restrictive level of imports is optimal.

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